August 30, 1996

MINUTES

TRI-SERVICE CADD/GIS TECHNOLOGY CENTER

ENVIRONMENTAL FIELD WORKING GROUP MEETING

July 31 - August 1, 1996

Holiday Inn On the Bay
San Diego, California

Final

Approved For Public Release; Distribution Is Unlimited

Tri-Service CADD/GIS Technology Center
Information Technology Laboratory
USAE Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, Mississippi 39180-6199

August 30, 1996

Meeting Agenda

Wednesday, July 31, 1996

0800 - 0830 **Introductions and meeting agenda** - Bobby Carpenter

0830 - 1230 **Field Trip to Navy Research and Development Center (NRaD) -** Chris Kyburg

1230 - 1330 **Lunch**

1330 - 1430 **AFCEE Emerging GIS/Modeling Opportunities Presentation** - Logos Yuen

1430 - 1445 **Break**

1445 - 1545 **Update on Tri-Service Center FY 96 Activities -** Bobby Carpenter

1545 - 1630 **Discuss Environmental FWG=s Proposed FY97 Project-** Group

1630 **Adjourn**

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Thursday, August 1, 1996

0800 - 1000 **SAS Demonstration** - Phil Hunter/SAS

1000 - 1015 **Break**

1015 - 1115 **Discuss Environmental FWG=s FY96 Project -** Bobby Carpenter

1115 - 1200 **Develop Scope of Work for Environmental FWG=s Proposed FY97 Project -** Christopher Kyburg/Group

1200 - 1300 **Lunch**

1300 - 1430 **Develop Scope of Work for Environmental FWG=s Proposed FY97 Project -** Christopher Kyburg/Group

1430 - 1445 **Break**

1445 - 1600 **Develop Scope of Work for Environmental FWG=s Proposed FY97 Project -** Christopher Kyburg/Group

1600 **Adjourn**

August 30, 1996

Future Environmental Field Working Group (FWG) Meetings

The next Tri-Service CADD/GIS Technology Center (Tri-Service Center) Environmental FWG meeting is tentatively scheduled for January 1997.

Environmental FWG Attendees

1. Name: Phil Hunter
   Title/Position: Hydrologist
   Address: HQ Air Force Center for Environmental Excellence
   AFCEE/ERC
   8001 Arnold Drive
   Brooks AFB, TX 78235-5329
   Phone: 210-536-5281
   Fax: 210-536-5989
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2. Name: Christopher Kyburg
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   Code 1852, Environmental
   San Diego, CA 92132-5190
   Phone: 619-532-1998
   Fax: 619-532-2469
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3. Name: Steven C. Gonzales
   Title/Position: Environmental Engineer
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   200 Stovall Street
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   Phone: 703-325-0356
   Fax: 703-325-2156
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4. Name: Logos Yuen
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5. Name: Thomas H. Stephan, R.A.
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10. Name: Bobby Carpenter
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August 30, 1996

PROCEEDINGS

Introductions and Meeting Agenda

Mr. Bobby Carpenter, Tri-Service Center, passed out copies of the meeting agenda and the Environmental FWG=s FY 97 project proposal entitled AInteractive Demonstration/Tutorial of Environmental Geographic Information System (GIS) Technology@. The project proposal was developed by the Environmental FWG during the May 1996 meeting, and later refined at the Tri-Service Center. A copy of the project proposal is included in Appendix A.

In addition, each person present at the meeting introduced themselves and provided a brief overview of their job and the activities in which they are involved.

Field Trip to Naval Command, Control and Ocean Surveillance Center (NCCOSC) Research, Development, Test, and Evaluation Division (NRaD)

Mr. Christopher Kyburg, Southwest Division NAVFACENGCOM, had organized the field trip to NRaD.

Background Information:

The Naval Command, Control and Ocean Surveillance Center (NCCOSC) Research, Development, Test and Evaluation Division (NRaD) is responsible for development of the technology to collect, transmit, process, display and, most critically, manage information essential to naval operations.

Headquartered in San Diego, California, and employing nearly 4,000 civilian and military personnel, NRaD develops the capabilities that allow decision-makers of the Navy, and increasingly of the joint services, to protect their own forces and carry out their operational missions. These capabilities include sensors to track submarines, surface ships and aircraft; communication networks and data links to transmit critical information; navigation systems to pinpoint position; command and control systems to process and display tactical information for officers in command. To support the system engineering and integration functions that are key to NRaD's efforts, the command also maintains research programs pushing the state-of-the-art in such diverse fields as atmospheric physics, electro-optics, underwater acoustics, engineering psychology, signal propagation and processing, artificial intelligence, material sciences, microelectronics, chemical oceanography, environmental and biological sciences.

NRaD leadership and technology areas are:

Command, control and communication systems
Command, control and communication system countermeasures

Ocean surveillance systems
Command, control and communication modeling and analysis
Ocean engineering
Navigation systems and techniques
Marine mammals
Integration of space communication and surveillance systems
Environmental quality technology
Microelectronics
Signal processing
High-performance computing
Display technology

Overview of Environmental Sciences Division - Mr. Peter Seligman:

Mr. Peter Seligman (NRaD (38), phone: 619-553-2760, E-mail: seligman@nosc.mil) provided an overview of the work performed by the Environmental Sciences Division (ESD) of NRaD. The Environmental Sciences Division is part of the Navigation and Applied Sciences Department at NRaD. Located in San Diego, California, the ESD is a leader in marine environmental quality assessment, sensor development, and remediation. The ESD draws on a broad range of in-house expertise and partnerships with industry, academia, and government to support the Navy with research, development, testing, and evaluation of environmental technology. Additional information concerning the NRaD ESD can be found under the APrograms and Projects@ link at the division=s Internet Homepage at URL address: http://environ.nosc.mil.

Environmental Data Management Presentation - Mr. Gerry Key:

Mr. Gerry Key (Computer Sciences Corporation, 4045 Hancock Street, San Diego, CA 92110-5164, E-mail: key@cscnet.com, fax: 619-553-6305) provided an overview of the work NRaD=s ESD is doing in the area of environmental measurements, databases, and data management. A copy of the presentation slides are included in Appendix B. In addition to the presentation slides Mr. Key demonstrated the access of environmental information from the San Diego Bay Regional Database from the San Diego Supercomputer Center=s Internet Web page at URL address: http://www.sdsc.edu/SDSC/Research/Comp_Bio/sdbay/sdbay.html. Mr. Key also presented the wiring diagram of the NCCOSC Command Internet (NCI) from the URL address: http://www.nci.net/nci/html/ncimap.html.

Visualizing Environmental Databases: GIS Presentation - Mr. Scott Kinghorn:

Mr. Scott Kinghorn (NRaD, phone: 619-553-6653, E-mail: kinghorn@nosc.mil) provided a presentation concerning the work the ESD is currently doing in visualizing environmental databases and with GIS. Intergraph MGE is the GIS software currently being used. The ESD has worked with the San Diego Supercomputer Center in developing HTML applications for accessing GIS database data via the Internet.

Simulation Modeling Demonstration - Mr. Don Sutton:

Mr. Sutton demonstrated environmental pollution simulation modeling work being accomplished at the ESD. The particular model demonstrated by Mr. Sutton was the Sediment

Model for San Diego Bay Area.

Tour of NRaD Facilities - Mr. Ken Grovhoug:

Mr. Grovhoug led the group on a tour of the NRaD facilities.

AFCEE Emerging GIS/Modeling Opportunities Presentation

Mr. Logos Yuen, AFCEE/ERC, provided a presentation of an Air Force environmental restoration GIS/Modeling initiative being conducted by the Air Force Center for Environmental Excellence (AFCEE) and the Air Force Phillips Laboratory.

One segment of the initiative is called SELECT, which will consist of a remediation strategist graphical user interface (GUI) developed in Visual Basic which integrates the operation of several different activities and software programs. When complete, SELECT will consist of a Site Characterization Model, a Risk Assessment Model, a Financial (Cost Estimating) Model, and a Transport Simulation Model. Assumptions used in the development of SELECT include (1) Based on remediation analysis, not simply cobbled-together models; (2) Uses scientifically defensible, state of the art models at each step; (3) and Integrates the analysis of uncertainty and variability as fundamental components, not as add-ons. SELECT users will be qualified people from each field of analysis, managers reviewing analyses and making decisions, and the public for reviewing analyses and decisions.

The Geophysical Data Fusion System (GDFS) consists of a computer workstation based data management, analysis, and visualization system. A prototype system is directed toward the specific application to the Massachusetts Military Reservation (MMR). It integrates an on-line environmental database for MMR (using the AF IRPIMS), together with a map-based graphical user interface (GUI) to link subsurface hydrogeological and other geophysical data.

The project management/project control (PM/PC) software is the AFCEE Contract Cost monitoring software. It provides cost down to item level to compare what if scenarios to support decisions at various Installation Restoration Program (IRP) projects.

The strength of SELECT, GDFS, and PM/PC will be integrated for a comprehensive system analysis when applicable. The specialties of each software package will be used. A potential cost savings for site characterizations is estimated to be between 50 to 70 percent when compared to current practice.

Implementation involves coordination of the concurrent development efforts to assure integrability of SELECT, GDFS, and PM/PC. Protocols for AFCEE Team Chiefs, consultants, and contractors including the following considerations will be developed:

Site Characterization and Monitoring Plan should included contingencies.

Negotiate Site Characterization and Monitoring Plan with regulators prior to plan initiation.

Project Points-of-Contact (POCs) include:
SELECT: Dr. Tom McKone (LBNL, phone: 510-486-6163) or Dr. Curt Oldenburg (LBNL, phone: 510-486-7419).
GDFS: Dr. Jim Leukowicz (AF Phillips Lab, phone: 617-377-2611).
PMPC: Ms. Dee Williams (AFCEE/ERS, phone: 210-536-5292).
Models Integration/Applications: Mr. Logos Yuen (AFCEE/ERC, phone: 210-536-4170).

Update on Tri-Service Center FY 96 Activities

Mr. Carpenter provided a brief overview of the Center organization and an update of the Tri-Service Center=s FY96 projects. The information presented is included in Appendix C.

Discuss Environmental FWG=s Proposed FY97 Project

Copies of the project scope which was developed at the May 1996 meeting were passed out during the morning session. The scope and intent of the proposed project were briefly discussed prior to meeting adjournment.

SAS Demonstration

Mr. Phil Hunter provided a brief introduction for the SAS demonstration. Mr. Chip Rhodes (SAS Institute, Inc., 6400 S. Fiddler=s Green Circle, Suite 1950, Englewood, CO 8011, phone: 303-290-9112 ext. 252, Fax: 303-290-9195, E-mail: sasacr@unx.sas.com) and Ms. Smita Shukla (SAS Institute, Inc., SAS Campus Drive, Cary, NC 27513, phone: 919-677-8000 ext. 1-7028, Fax: 919-677-4444, E-mail: sasshs@unx.sas.com) provided a demonstration of the capabilities of the SAS software. The company has a Web page on the Internet at URL address: http://www.sas.com/.

SAS System software is an information delivery system which provides a fully integrated, hardware-independent system of modular component products that provide an extensive range of computing capabilities. These capabilities, coupled with the SAS System=s powerful applications development environment, allow any individual in the organization to quickly and easily access and manage data and applications stored in virtually any file format on any computing platform, from mainframe to laptop personal computer (PC).

Data Management, Analysis, and Presentation:
The SAS System=s data integration capabilities permit the access of data stored in virtually any file structure on a wide range of operating systems. Data stored in flat files to database management systems (DBMS) such as dBase and Oracle. SAS System software offers

a powerful, high-level programming language; and industry-standard Structured Query Language (SQL); and other tools and capabilities that allow you to enter, edit, merge, sort, subset, and concatenate data, and well as other data management tasks. The SAS System=s software provides the tools needed to analyze the data, such as statistical analysis, modeling, forecasting, project management, statistical quality improvement, and data analysis. SAS System software provides a broad range of data presentation capabilities, such as simple lists, reports, charts, maps, and plots to free-form designs, two- and three-dimensional graphs, and animation sequences.

SAS/GEO software, a fully integrated component of the SAS system, integrates disparate geoscience and environmental data and applications into a single GUI-based desktop environment. SAS/GEO is intended for processing large amounts of local and remote data in formats and applications external to the SAS System, and offers an efficient data-exchange mechanism that allows data to be shifted easily from application to application, regardless of digital format.

SAS/SPECTRAVIEW software, the SAS System=s data visualization and analysis tool, allows the creation, analysis, and modification of geometric images.

Discuss Environmental FWG=s FY96 Project

Mr. Carpenter passed out copies of the scope and questionnaire form for the Environmental FWG=s FY96 project entitled AIdentify and Review Environmental Restoration/Compliance (ER/EC) Initiatives and Communicate with other Organizations.@ A copy of the scope in included in Appendix D. A brief update concerning the status of the project was provided and the group reviewed the Microsoft Access database containing the collected information.

Mr. Steven Gonzales and Mr. Brian Shin, HQ NAVFAC, were at the Tri-Service Center from 15 - 19 July 1996 for the purpose of completing the telephone interviews and inputting the additional data into the database (i.e., the ER/EC Database). The ER/EC Database currently contains 62 records concerning the use of CADD/GIS technology for ER/EC work, 53 records concerning the availability of electronic ER/EC data, 28 records concerning ongoing ER/EC initiatives, 61 records concerning types of ER/EC work performed, 173 records of ER/EC points-of-contact, and 54 records concerning available Internet Web sites and/or Bulletin Board Services. The final step in the project involves completing a technical report summarizing the findings and making the information available on the Tri-Service Center=s Internet Web site.

An Internet Web site has been developed at the Tri-Service Center for the Environmental FWG at URL address: http://fwgcom.wes.army.mil/fwg/environ/environ.htm. The Environmental FWG Web site contains (1) HTML hypertext links to the identified Internet Web sites containing ER/EC data ; (2) Digital copies of meeting minutes; (3) Digital presentations and papers concerning Environmental Restoration and Compliance issues: (4) Environmental symbols and design details; (5) and Environmental FWG products and items of interest.

Develop Scope of Work for Environmental FWG=s Proposed FY97 Project

Mr. Christopher Kyburg led the group in developing a more detailed scope of work for the proposed FY97 project entitled AInteractive Demonstration/Tutorial of Environmental Geographic Information System (GIS) Technology@. A copy of the project proposal is included in Appendix A.

1. The intended audience will be:
   General Interest.
   - C. Management Overview
   - C. Technical Reference
   - C. Tutorial.
   - C. RAB/Public Education.
   - C. Contractor Support.

A small scale map (e.g., USGS, state, etc.) and a large scale map (e.g., installation base map) will be provided. The maps will probably be in a GIF digital format. The basic areas of interest on the base map will include one landfill, one lake, roads, perimeter fence, one airstrip, and buildings.

The introductory screen will be subdivided into the following three general areas:
   General Information.
   - C. Management Type Information.
   - C. Technical Information.

Items to be addressed in the introductory screens will include at least the following:

a. What is GIS technology?
b. Why use GIS for Environmental Restoration and Compliance activities? Cost benefits, make better decisions, etc.
c. What are the Tri-Service Spatial Data Standards (TSSDS)? Use Release 1.6.
d. Why do we need GIS standards?

Provide Overview and Demonstrate the use of the Environmental Symbols.

Discuss Format and Organization of the TSSDS. Capability will be provided to select a category which will lead through a hypertext link to another screen providing more detailed information.

Entity Sets.
(1) Entity Classes.
(2) Entities (Entity Types).
(3) Attribute Tables.
(4) Domain Tables.
(5) Join Relationships.

At least the following Entities, with associated Attribute and Domain Tables, should be

covered. The Attribute and Domain Tables will be accessed by selecting the entity from the map. When an Entity feature is selected from the map a hypertext link will lead to another screen providing a description/definition of that entity and a button which when selected retrieves the Attribute Table for the Entity.

DoD Installation Restoration Program (IRP) Site.

(1) Area of Potential Concern.
(2) Soil Sample Collection Location.
(3) Air Sample Collection Location.
(4) Monitoring Well.
(5) Contained Hazardous Materiel Storage Area.
(6) Contained PCB=s.
(7) Landfill Cell.
(8) Solid Waste Landfill.
(9) Temporary Stockpile Area.
(10) Excavation Area.
(11) Hazardous Waste Remediation Incinerator.
(12) Building with Environmental Hazards.
(13) Spill Containment Feature.
(14) Spill Response Staging Area.
(15) Equipment Decontamination Pad.
(16) Exclusion Zone.
(17) Staging Area.

Air Pollution Isoline.
Air Emission Source Point.
Soil Pollution Isoline.
Soil Pollution Plume.
Groundwater Pollution Isoline.
Groundwater Pollution Plume.
Sediment Pollution Isoline.
Sediment Pollution Plume.

(1) Spill Release Point.

Nonpoint Source Pollution Area.
Regulated Underground Storage Tank.

(1) Regulated Aboveground Storage Tank.

h. Examples of Plumes, sample Queries, and Animation can also be provided.

Contract requirements would consist of the following. The Environmental Sciences Division (ESD) of NRaD has expressed interest in assisting the Environmental FWG in development of the project. Mr. Kyburg will request a proposal from them.

Self-Contained CD-ROM.

a. Nor Proprietary Software.
b. AReasonable@ access speed on Internet.

Demonstrate implementation of Release 1.6 of the TSSDS for Environmental Restoration and Compliance.

Allow 30 day review time between milestones.

c. Provide milestone deliverables in electronic format to Tri-Service Center.
d. Typical milestones should be as follows:
   (1) AEmpty@ GIF of large scale map (i.e., base map) and small scale map (i.e., USGS Quad Map). Identify browser/viewer(s).
   (2) Develop screen shots: Highest level through Entity screens for one Entity Set.

   Make above items fully functional for one Entity.

   (3) Develop screen shots for identified Entities/Entity Classes.
   (4) Make all Entity screen shots fully functional.
   (5) Complete Environmental and other Identification Entities.
   (6) Provide fully functional product.

Supplemental Information

Mr. Bill Lopp provided a copy of a document entitled AAETC Environmental Data Management Action Plan@ which was prepared for the Air Education and Training command (AETC) of the U.S. Air Force (USAF) by Radian Corporation. A copy of the document is included in Appendix E. The purpose of the document is provide an Implementation Plan for collecting and managing the complex and diverse data collected and used under the Installation Restoration Program.

A paper entitled AEnvironmental Restoration and Compliance Spatial Data Management@, which was passed out to the group is included in Appendix F.

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Appendix A

Environmental FWG's Proposed FY97 Project

Interactive Demonstration/Tutorial of Environmental Geographic Information System (GIS) Technology

August 30, 1996

FY 97 PROJECT PROPOSAL
for
The Tri-Service CADD/GIS Technology Center

Project Title: Interactive Demonstration/Tutorial of Environmental Geographic Information System (GIS) Technology

Originating Office:	Environmental Field Working Group FY 97 Project	
Name:	Christopher Kyburg	***Proponents:***
Office/Code:	SWDiv, NAVFAC Code 18	Navy: Christopher Kyburg, Steve Gonzales, Tom Stephan
Mailing Address:	1220 Pacific Hwy	Army: Bart Ives
City	San Diego	Corps: James Huang, MK Miles, Larry Mann, Sam Bass
State	California	Air Force: Gary Huneycutt, Phil Hunter, Logos Yuen
Zip Code	92132-5190	
Phone Number	619-532-1998	

Requirement:

There is a need to improve the understanding in the field of how to apply the Tri-Service Spatial Data Standards (TSSDS) and Symbols to environmental coverages in a GIS, and how to integrate the use of the TSSDS in the life cycle approach to accomplishing environmental restoration and compliance activities. The tool will be able to fulfill many training and demonstration needs to the field.

Justification and /or Benefits:

An interactive on-line demonstration/tutorial will greatly enhance understanding of use of the standards for Environmental Restoration and Compliance. This project will create such a system using public domain web technology. The TSSDS provides an extensive graphic (symbology) and nongraphic (database) schema which will serve as a standard format for the use of Computer-Aided Drafting and Design (CADD) and GIS technology in accomplishing various Tri-Service activities. However, there remains a general lack of understanding in the field of how to use the TSSDS as a tool in accomplishing environmental restoration and compliance activities. Guidance and training methods have to be developed in order to overcome this lack of understanding.

Requirement/Objective:

The objective of the project is to provide an on-line training and demonstration tool to help the field understand the application of the TSSDS and Symbols to Environmental Engineering available at no cost to the field. The tool would also be installed on a laptop computer for demonstration purposes at conferences, meetings, and training sessions.

Approach:

Develop an interactive on-line training and demonstration tool. The tool will be installed on the Tri-Service CADD/GIS Technology Center's Environmental FWG's Internet web page, as well as provided on a floppy disk/CD for distribution to the field. The tool will be installable on a laptop computer for demonstration purposes at conferences, meetings, and training sessions. The tool will provide the following minimum capabilities: (1) an overview of the life-cycle approach to environmental restoration and compliance; (2) an overview of GIS technology and benefits in the field of environmental engineering; (3) an overview of the TSSDS

with guidance on how to implement the TSSDS to accomplish environmental restoration and compliance activities; (4) interactive maps (small scale and large scale maps accessible through the Internet and transportable on a laptop computer) which demonstrate the use of the environmental graphic (symbology) and nongraphic (database) standards contained in the TSSDS; (5) sample queries; and (6) an overview of data acquisition, conversion, and formatting methods and procedures. Create interactive maps which demonstrate the standards at various map scales and categories of environmental restoration and compliance. The maps would represent the symbols and standards used for the various media (air water UST etc.). Each symbol when selected will provide example data and additional buttons which will offer insight, an example query, database schema, benefits of GIS, etc., associated with the graphical entity.

Costs:

FY 97 - $75,000

Product:

Electronic software installed on Tri-Service Center's Internet web page and floppy disk/CD.

Customers:

All DoD personnel, and their contractors, performing environmental restoration and compliance activities.

Remarks:

This is the Environmental Field Working Group FY97 project. The Environmental Field Working Group can develop a Scope of Work, and a contract awarded to the Tri-Service Center's GIS contractor in FY96, if adequate funds are available.

Project Functional Categories:

Training and Installation Support.

Appendix B

NRaD Presentation

A digital copy of the presentation is available in a Microsoft PowerPoint 4.0 format under filename = TALK_V4.PPT.

A paper copy can be obtained by providing your name, address, and phone number/Fax number to:

Mr. Bobby Carpenter
Tri-Service CADD/GIS Technology Center
USAE Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
phone: 601-634-4572
Fax: 601-634-4584
E-mail: carpenb@ex1.wes.army.mil

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Appendix C

Overview of Tri-Service CADD/GIS Technology Center and Update on FY96 Projects

A digital copy of the presentation is available in a Microsoft PowerPoint 4.0 format under filename = 071196a.PPT

A paper copy can be obtained by providing your name, address, and phone number/Fax number to:

Mr. Bobby Carpenter
Tri-Service CADD/GIS Technology Center
USAE Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
phone: 601-634-4572
Fax: 601-634-4584
E-mail: carpenb@ex1.wes.army.mil

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Appendix D

Environmental FWG's FY96 Project

Task No. 106

Identify and Review Environmental Restoration/Compliance Initiatives and Communicate with other Organizations

August 30, 1996

FUNCTION: COMMUNICATION

STRATEGY: COMMUNICATION

TASK#: **106**
TITLE: IDENTIFY AND REVIEW ENVIRONMENTAL RESTORATION/COMPLIANCE INITIATIVES AND COMMUNICATE WITH OTHER AGENCIES/ORGANIZATIONS

1. Originating Office:

Environmental Field Working Group, Chairperson: Chris Kyburg, SOUTHWESTDIV NAVFACENGCOM, Code 1813.CK, 1220 Pacific Hwy, San Diego, CA 92132, phone: (619)532-1229, FAX: (619) 532-2469, E-mail: cekyburg@efdswest.navfac.navy.mil

Vice Chairperson: Sam Bass, CEMRD-ED-TG

Air Force Proponent - Gary Huneycutt
Army Proponent - Bart Ives/Rik Wiant (703-695-1375/355-0086), ives@pentagon-acsim1.army.mil
Corps Proponent - James Wolcott (202-761-1200), James Huang (202-761-8883)
Navy Proponent - Stephen Gonzales/Jim Carberry
Center POC - Bobby Carpenter
FWG Proponent - Steve Gonzales

2. Requirement: Facilitate the transfer of information between various Tri-service organizations, the Environmental Protection Agency (EPA), and other appropriate organizations in the field of environmental restoration and compliance.

3. Justification/Benefits: There is duplication of effort and insufficient communication in numerous areas involved with the accomplishment of environmental restoration and compliance activities. Many times DoD installations located in close proximity expend resources gathering duplicate information. The lack of communication between the Tri-services, federal, state, and local organizations results in the inefficient utilization of resources.

4. Objectives: Objective is to provide a means to transfer information and communicate with various Tri-service organizations, the Environmental Protections Agency (EPA), and other appropriate organizations in the field of environmental restoration and compliance.

5. Approach:

a. Develop questionnaire for use in telephone interviews, for mailout, and for posting on the Tri-Service CADD/GIS Technology Center's (TSTC's) Internet Homepage.

b. Contact various DoD Field Operating Activities FOAs, EPA (HQ and Regions), non-DoD federal agencies, state and local agencies, universities, and institutions to identify environmental CADD/GIS restoration and compliance initiatives and information sources. Contact will be made through a combination of telephone interviews and mailed questionnaires.

c. Design database and HTML application permitting direct input of the questionnaire information on the TSTC's Internet Homepage.

d. Develop hardcopy and electronic report summarizing findings. Publish hardcopy report. Make electronic report available on the TSTC's Homepage.

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FUNCTION: COMMUNICATION

STRATEGY: COMMUNICATION

TASK#: **106**
TITLE: IDENTIFY AND REVIEW ENVIRONMENTAL RESTORATION/COMPLIANCE INITIATIVES AND COMMUNICATE WITH OTHER AGENCIES/ORGANIZATIONS - Page 2

6. Cost: $30,000

7. Product: Written and electronic report summarizing identified information concerning CADD/GIS environmental compliance and restoration initiatives and activities, along with a mechanism for continual input and update of initiatives and activities on the TSTC's Internet Homepage.

8. Customers: Project managers, geologists, engineers, facility engineers, and other personnel involved with environmental restoration/compliance activities.

9. Remarks: This is the Environmental FWG's FY-96 project.

August 30, 1996

Appendix E

AETC Environmental Data Management Action Plan

A paper copy can be obtained by providing your name, address, and phone number/Fax number to:

Mr. Bobby Carpenter
Tri-Service CADD/GIS Technology Center
USAE Waterways Experiment Station
3909 Halls Ferry Road
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Appendix F

Environmental Restoration and Compliance Spatial Data Management Paper

ENVIRONMENTAL RESTORATION AND COMPLIANCE SPATIAL DATA MANAGEMENT

Bobby G. Carpenter, PE
Tri-Service CADD/GIS Technology Center,
USAE Waterways Experiment Station
Vicksburg, MS

ABSTRACT

The Tri-Service CADD/GIS Technology Center (Tri-Service Center) was established by the Department of Defense (DoD) at the Army Waterways Experiment Station, Vicksburg, Mississippi in October 1992. The Tri-Service Center=s mission is to serve as a multi-service vehicle to set standards; coordinate facilities computer-aided design and drafting (CADD) and geographic information system (GIS) systems within the DoD; promote system integration; support centralized acquisition; and provide assistance for the installation, training, operation, and maintenance of CADD and GIS systems. One of the Tri-Service Center=s tasks has been the development of spatial data standards for facilities at the organizations within DoD (e.g., Air Force, Army, and Navy). Release 1.4 of the Tri-Service Spatial Data Standards (TSSDS) was released in August, 1995. This is the first release to be widely distributed on CD-ROM within DoD. Both graphic (e.g., symbols, text fonts, line styles/types, and level/layer schemas) and nongraphic (e.g., attribute and domain tables) spatial data requirements have been addressed in the TSSDS. The standards are designed to operate with the commercially available CADD software (e.g., Bentley's MicroStation and Autodesk's AutoCAD), GIS software (e.g., Intergraph's MGE and ESRI's ARC/ INFO), relational database management software (e.g., Oracle and Informix (SQL)), and computer systems (e.g., workstations with UNIX or Windows NT, or PCs with MS-DOS, Windows 3.1, or Windows NT) most commonly used today. The TSSDS consists of four basic levels of hierarchy: Entity Sets, Entity Classes, Entity Types, and Attribute Tables. The Entity Classes in the Environmental Hazards Entity Set include, among others: Site Management; Characterization; Hazardous Materiels and Hazardous Waste Management; Munitions Materiels and Munitions Residues Management;

Emergency Preparedness; Air, Soil, Groundwater, Surface Water, Sediment, and General Pollution; Pollution Remediation; Building Environmental Hazards; and Regulated Tank Management.

BACKGROUND

Why Do We Need Standards?

The collection, storage, management, and analysis of information (i.e., data) is a critical, and one of the most expensive, components of environmental cleanup and compliance activities. There are currently no comprehensive DoD, federal, or industry standards for the storage, management, and analysis of this data. The data is stored in numerous different types of paper, microfilm, and electronic formats which are not readily accessible and usable by various DoD and regulatory organizations. The full potential of using Geographic Information System (GIS) technology as a tool in accomplishing environmental cleanup and compliance activities cannot be realized until consistent

standards for the storage, management, and analysis of the data are implemented, and Auser friendly@ applications are developed.

Development of Spatial Data Standards

One of the Tri-Service Center's assigned tasks has been the development of spatial data standards for facilities at the organizations within the DoD (e.g., Air Force, Army, and Navy).

Release 1.4 of the Tri-Service Spatial Data Standards (TSSDS) was distributed in August, 1995. This is the first release to be widely distributed on CD-ROM (CD) within the DoD. Approximately two thousand copies of the Release 1.4 CDs were made and have been distributed on CD-ROM. The most current release of the TSSDS can also be obtained from the Tri-Service Center's Internet Homepage at URL address: http://mr2.wes.army.mil. The CD version of the TSSDS contains an interactive Microsoft Windows application which runs on personal computers and computer workstations using a Windows 3.1, 95, or NT operating system. The application permits the user to (1) browse and review the data standards components, (2) preview and print standards documents, and (3) generate SQL code schema.

The TSSDS are currently being implemented on GIS by numerous DoD installations, and by Architect-Engineer (A-E) and consulting firms accomplishing work for DoD, other federal, state, and local government organizations. The TSSDS has been implemented at the Tri-Service Center on a pilot Automated Facility Master Plan project in both the Intergraph MGE/MGA and ESRI ARC/INFO GIS formats.

Release 1.6 of the TSSDS is scheduled to be available in early Fiscal Year 1997 (i.e., October or November 1996).

Additional data coverages will be incorporated into the TSSDS each year, as funding permits.

Contributors and Coordination

The TSSDS has been developed based upon input from various DoD technical experts, the review and analysis of working GISs, and the review and analysis of various existing database management systems (DBMSs). Some of the DoD initiatives and existing DoD DBMSs contributing to the content of the TSSDS include: (1) Air Force AInstallation Restoration Program Information Management System@, (IRPIMS), Version 2.3, May 1994; (2) USAE District AEnvironmental Data Management System@ (EDMS), Version 1.0, February 1995; (3) Army Environmental Center (AEC) AInstallation Restoration Data Management Information System@ (IRDMIS); (4) Southwest Division Naval Facilities Engineering Command, ANavy Environmental Data Transfer Standard@, (NEDTS), Version 2, February 1995; (5) USAE AFormerly Used Defense Site (FUDS) Database - Users Guide@, Version 1.04; (6) Air Force Aeronautical Systems Center (ASC) and USAE District, Louisville ADraft System Specification for the Technical Data Management System@, March 1995; (7) Defense Environmental Security Corporate Information Management (DESCIM) ACleanup@ Data Modeling Work Group, FY95 meetings; and (8) working GISs at Edwards AFB and Patuxent River Naval Air Station. The Tri-Service Center has, and is, coordinating the development of the TSSDS with other DoD

and Federal standards initiatives, such as the Defense Environmental Security Corporate Information Management (DESCIM) program, the Federal Geographic Data Committee (FGDC), and the Defense Information Standards Agency (DISA).

Content Standards for Digital Geospatial Metadata

The ability to use existing geospatial data is important to individuals in the various organizations who are trying to share data. This ability depends on being able to find data and to understand the c-haracteristics and quality of the data. Metadata or "data about data" are a key to developing this ability. Metadata describe the content, quality, condition, and other characteristics of geospatial data.

Office of Management and Budget (OMB) Circular A-16, entitled ACoordination of Surveying, Mapping, and Related Spatial Data Activities@ established an interagency coordinating committee known as the Federal Geographic Data Committee (FGDC), whose objective is to promote the coordinated development, use, sharing, and dissemination of surveying, mapping, and related geospatial data. OMB Circular A-16 also established a process to promote the development of a national spatial framework for an information-based society with the participation of Federal, State, and Local governments, and the private sector, and to reduce the duplication of effort.

The Federal Geographic Data Committee (FGDC) has been charged with the responsibility of developing standards for the format and content of geospatial metadata. These standards are known as the FGDC Metadata Standard.

Executive Order 12906, ACoordinating Data Acquisition and Access: The National Spatial Data Infrastructure@, which was signed by the President on 11 April 1994, requires that all Federal agencies use the FGDC Metadata Standard to document new geospatial data and make them electronically accessible through the use of a National Geospatial Data Clearinghouse.

The Secretary, through the FGDC, and in consultation with, as appropriate, State, local, and tribal governments and other affected parties, is responsible for the establishment of the National Geospatial Data Clearinghouse (Clearinghouse) for the National Spatial Data Infrastructure (NSDI). The Clearinghouse is intended to be a distributed, electronically connected network of geospatial data producers, managers, and users. When fully functional, the Clearinghouse will allow its users to electronically (via the Internet) determine what geospatial data exists, find the data they need, evaluate the usefulness of the data for their applications, and obtain or order the data as economically as possible.

The FGDC Metadata Standard has been incorporated into the TSSDS.

Geospatial Data Systems (GDSs)

The spatial data standards were developed to provide basic graphic (e.g., colors, fonts, level/layer schemas, symbology) and nongraphic (e.g., database schema) standards for the development of Geospatial Data Systems (GDSs). A geospatial data system (GDS) consists of any automated system that employs data referenced to a location on the earth.

These automated systems include Geographic Information Systems (GISs), Land Information Systems (LISs), Remote Sensing or Image Processing Systems, Computer-Aided Design and Drafting (CADD) systems, Automated Mapping/Facilities Management (AM/FM) systems, Automated Mapping (AM), and other computer systems that employ or reference data using either absolute, relative, or assumed coordinates. When both the data and systems are referred to, the term Geospatial Data and Systems (GD&S) is used.

The predominant types of GDS software which are used in environmental restoration and compliance activities are:

Computer-Aided Design and Drafting

Geographic Information System (GIS).

Computer-Aided Design and Drafting (CADD)

CADD technology has become the preferred method for the preparation, distribution, storage, and maintenance of engineering type design drawings and maps. With CADD systems, graphic three-dimensional or two-dimensional digital data is placed on various drawing layers that can be selectively displayed and edited.

The TSSDS has been developed to be used with the two predominant commercially available CADD software packages currently used by DoD organizations: AutoCAD (Autodesk) and MicroStation (Bentley).

Geographic Information System (GIS)

GIS technology provides a computerized mechanism for capturing, verifying, storing, manipulating, querying, analyzing, and displaying geospatial data referenced to it's location on earth. GIS technology has evolved from the computerized applications of cartography and map analysis which were first developed in the 1960s. However, it's practicality and widespread use has only been realized in fairly recent years due to the rapid advancement of computer hardware and operating system software capabilities.

The basic components of a GIS system are the GIS software (including application software), the database management system (DBMS) software, the computer platform (i.e., hardware and operating system), the database schema or structure, the data, and the digital media containing the graphic and attribute geospatial data. There are considerable differences in the capabilities of the commercially available GIS software on the market today. Until recently, with the development and proliferation of the Microsoft Windows NT operating system and the advancement in Portable Computer (PC) capabilities, most GIS software operated on UNIX based workstations. Today, the GIS market is growing and changing at a rapid pace. Also, the gap between the capabilities and operational characteristics of traditional CADD and GIS software are rapidly narrowing.

GIS differs from CADD in that spatial relationships among all data elements are defined through a convention known as topology. Topology provides a mechanism for describing the location, geometry, and

characteristics of map features, as well as how linear map features are connected, how areas are bounded, and which areas are contiguous. A GIS uses a special database structure to define map topology. All map features are defined as either a point (node), line (arc), or polygon (area).

Point features are used to represent map or drawing features which are identified as a symbol or label (i.e., objects whose shape or boundary is too small to be shown as a line or polygon at a particular map scale); the points at the beginning, end, and intersections of lines which represent nodes (used primarily for utility networks); and incident locations (e.g., where a break was repaired in a waterline). For most GIS software product, each point is assigned a unique identification number, and is located by a coordinate value (i.e., x, y, and sometimes z (elevation)) geographic coordinate values.

Line features are described by a series of coordinate pairs (i.e., x, y, and sometimes z), and are assigned a unique identification number. Two coordinate pairs, one for the beginning and one for the end of the line, are needed to fully describe a straight line. Many coordinate pairs may be needed to fully describe a curvilinear feature. Line features are used to represent objects which are too narrow to display as a polygon at a particular map scale (e.g., a highway or stream), or an object that has no width (e.g., a contour line).

Polygon features represent a defined bounded area. A polygon's boundary is represented by a closed line, or series of lines. Each polygon has a uniquely identified centroid, which is a point located anywhere within the area. A coordinate pair defines the location of the centroid.

The true value of a GIS is that it permits the query and analysis of the graphic and associated attribute data. Attribute data is nongraphic data which describes or provides detailed information concerning spatially related features on a map or drawing. The attribute data is stored in a RDBMS separate from the graphics data. Each attribute table is electronically linked, or attached, to the appropriate spatial feature to which it is related. The attribute table containing data describing a polygon feature is attached to the polygon's centroid, feature (i.e., boundary), or label. The attribute table containing data describing a point or line is attached directly to the point or line feature, point or line label.

There are considerable differences in the capabilities of the commercially available GIS software on the market today. With the growing popularity of GIS technology, numerous software packages are being developed which are advertised as providing GIS capability. The various GIS software packages on the market today will be broken down into the following broad categories:

Workstation GIS Software

PC GIS Software

Desktop Mapping Software

Workstation GIS Software

Workstation GIS software provides all of the data capture, storage, editing, retrieval, analysis, and display capability that is available from GIS technology. Because of it's extensive capability, workstation GIS requires either a UNIX or Windows NT based workstation platform to operate.

The TSSDS has been designed to be used with the two predominant commercially available GIS software programs currently used by Tri-Service organizations: ARC/INFO (Environmental Systems Research Institute, Inc. (ESRI)) and MGE/MGA (Modular GIS Environment/Modular GIS Analysis) (Intergraph).

PC GIS Software

PC GIS software is capable of providing a significant amount of data capture, storage, editing, retrieval, analysis, and display capabilities, but not to the extent provided by Workstation GIS software. PC GIS software is used extensively for AM/FM type applications.

The TSSDS has been designed to be used with PC GIS software, such as PC ARC/INFO (ESRI), ARC/CAD (ESRI), PC MGE (Intergraph), AutoCAD Map (Autodesk), and GeoGraphics (Bentley).

Desktop Mapping Software

Desktop mapping software (also called desktop GIS, and data visualization software) typically can provide retrieval, analysis, and display capabilities. The data capture, storage, and editing of the geospatial data is accomplished with either Workstation GIS software or PC GIS software.

The TSSDS has been designed to be used with desktop mapping software such as ARC/VIEW (ESRI), VistaMap (Intergraph), and MapInfo (MapInfo).

Database Management Systems (DBMS)

A database consists of a structured and organized collection of information . A DBMS is a computer program which provides for the management of the data, or information, contained in a database. A relational DBMS (RDBMS) is a computer program which provides a means of managing the related data contained in one or more database tables.

The computer language which has been developed for organizing, managing, interacting, and retrieving the data stored in a RDBMS is called Structured Query Language (SQL).

The American National Standards Institute (ANSI) and the International Standards Organization (ISO) originally published standards for SQL in 1986. The ANSI/ISO SQL standards were significally expanded in 1992. SQL is also included in the U.S. Federal Information Processing Standard (FIPS).

The TSSDS has been designed to be used with any type of commercially available RDBMS. Oracle (Oracle Corporation) and Informix (Informix Corporation) have traditionally been the most widely used

RDBMS by Tri-Service organizations. dBase has also been widely used as a DBMS (i.e., non-SQL). INFO (Henco Software, Inc.) is a flat-file DBMS which is bundled and distributed with ARC/INFO (ESRI). The growing popularity of Windows NT (Microsoft) has resulted in the growth in popularity of RDBMSs complying with Microsoft's Open Database Connectivity (ODBC) standard, such as Access (Microsoft). Other popular RDBMS include Foxpro (Microsoft), Sybase, Paradox (Borland), SQL Server (Microsoft).

DATA MODEL STRUCTURE

Both graphic (e.g., symbols, text fonts, line styles/types, and level/layer schemas) and nongraphic (e.g., database attribute tables and domains) spatial data requirements have been addressed in the TSSDS.

The TSSDS data model consists of four basic levels of hierarchy: Entity Sets, Entity Classes, Entity Types (Entities), Attribute Tables, and Domain Tables (See Table 3).

Entity Sets

Entity Sets (or Themes) are a broad grouping of features and data. The TSSDS structure includes twenty four entity sets. The entity sets currently included in the TSSDS are listed in Table 1.

Table 1
TSSDS Entity Sets

1. Landform
2. Geology
3. Soil
4. Hydrography
5. Flora
9. Buildings
10. Improvements
11. Utilities
12. Communications
13. Boundary

6. Fauna
7. Climate
8. Visual
17. Olfactory
18. Auditory
19. Cultural Hazards
20. Land Status
14. Cadastre
15. Geodesy
16. Transportation
21. Demographics
22. Military Operations
23. Environmental
24. Common

Entity Classes

Entity Classes are a general grouping of features within an Entity Set for data management purposes. Most of the features required for environmental restoration and compliance activities are included in the Environmental Hazards entity set. Sixteen entity classes were included in Release 1.4 of the TSSDS. Seventeen entity classes are included in Release 1.6, as indicated in Table 2.

Table 2
Environmental Hazards Entity Classes

1. Site Management
2. Characterization
3. Hazardous Materiels and Hazardous Waste Management
4. Munitions Materiels and Munitions Residue Management
5. Solid Waste Management
6. Pollution Remediation
7. Building Hazards Remediation
8. Emergency Preparedness
9. Munitions Remediation
10. General
11. Air Pollution
12. Soil Pollution
13. Groundwater Pollution
14. Surface Water Pollution
15. Sediment Pollution
16. General Pollution
17. Regulated Tanks (in Release 1.6)

Additional features required for environmental restoration and compliance activities may be found in other entity sets, such as Geology where borehole is located.

Entities

Entities (*Entity Types)* are items which appear graphically on a map or drawing. Entity Types can be grouped into the following three categories of *entities*.

Boundary (G/GT Polygon) - A line string (or group of arcs) which forms the perimeter and the interior of an area. An example would be the boundary of a groundwater pollution plume.

Point - A single point representing the geographical location of a feature (e.g., a monitoring well). Points are normally represented on a map by a symbol. *Symbols have been developed in the native formats of AutoCAD, MicroStation, and ARC/INFO and provided with the TSSDS. Most of the symbols which are available can be viewed and downloaded from the Tri-Service Center's Internet Homepage (URL address: http://mr2.wes.army.mil) or from the Tri-Service Center's Environmental FWG's Internet Homepage at URL address: http://fwgcom.wes.army.mil/fwg/environ/environ.htm.*

String/Chain - A line or group of arcs.

Attribute Tables

An *attribute table* is a relational database table containing non-graphic, or attribute, information about an entity. Attribute tables which are linked directly to a graphic entity and contain data directly related to that entity can be classified as "graphic"

attribute tables. Attribute tables not directly linked to an entity but, contain data required for a "business process", or function, along with data and relationships linked through specific data field ids which may be queried for geospatial and relational analysis can be classified as "nongraphic" attribute tables.

Domain Tables *Domain Tables* contain lists of codes (i.e., permissible or valid values) for populating specific fields in the attribute tables. For example, units of measure, material types, etc.

Environmental Entities and Attribute Tables

Some of the entities with associated "graphic" attribute tables and "nongraphic" attribute tables in the Environmental Hazards Entity Set of the TSSDS are included in Tables 3 and 4.

Join Relationships

Join relationships are mechanisms by which relational databases link multiple records of a common attribute or item, and provide access to the records through the use of queries. Join relationships are established in the TSSDS through the use of Primary Key fields and Foreign Key fields.

For example, a "parent" attribute table for an Environmental Hazards Site has been established with a Primary Key field called "hazsite_id". Each Environmental Hazards Site will be assigned a unique identification name/number, e.g., hazsite100 for Environmental Hazards Site Number 100. The "hazsite_id" field is included as a Foreign Key field in all other attribute tables which may be related to the site. In addition, a "parent" attribute table for a Field Sample Collection Location has been established with a Primary Key field called "sam_pt_id". Each location where a soil, air, sediment, surface water, groundwater, biological, waste, or solid field samples are collected for analysis will be assigned a unique identification name/number, e.g., soilsampt100 for soil sample point number 100. The attribute tables which define the collection locations and analytical results for all field samples (i.e., soil, sediment, air, surface water, groundwater, biological, waste, and solid) collected at various Environmental Hazards Sites contain the Foreign Key, "hazsite_id". All of the field sample collection locations located within each Environmental Hazards Site can easily be determined by querying the hazsite_id field of the appropriate attribute tables. Also, all of the analytical results for the field samples collected at each field sample collection location can also be determined by querying the "sam_pt_id" field of the appropriate attribute tables.

REFERENCES

Korte, George B., The GIS Book, OnWord Press, Santa Fe, 1992.

Tri-Service CADD/GIS Technology Center, ATri-Service Standards, Part 3, Spatial Data Standards@, Release 1.4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Tri-Service CADD/GIS Technology Center, ATri-Service Standards, Part 1.2, A-E GIS Deliverables Standards@, Release 1.0, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Table 3
Examples of the Spatial Data Standards Data Model

Entity Set (Broad Theme)	Entity Class (General Grouping within Entity Set)	Entity (Graphic Features on Map/Drawing)	Attribute from Attribute Table (Information about an Entity)	Domain from Domain Table (Permissible/Valid Values for the Attribute)
Environmental Hazards	Characterization	Soil Sample Collection Location	ltccode_id (sample collection location class)	BH (for borehole)
Environmental Hazards	Site Management	DoD Installation Restoration Program Site	hrs_score (hazard ranking score)	

Table 4
Selected Environmental Hazards Entity Set Entities with Associated Attribute Tables

Entity Class 1: Site Management

- **DoD Installation Restoration Program (IRP) Site**
- **DoD Formerly Used Defense Site (FUDS)**
- **Superfund Site**
- **Area of Potential Concern**
- Point of Potential Concern

Entity Class 2: Characterization

- Soil Sample Collection Location (Release 1.6)
- Sediment Sample Collection Location (Release 1.6)
- Surface Water Sample Collection Location (Release 1.6)
- Groundwater Sample Collection Location (Release 1.6)
- Air Sample Collection Location (Release 1.6)
- Biological Sample Collection Location (e.g., plants and animals) (Release 1.6)
- Solid Sample Collection Location (e.g., asbestos, lead, building material) (Release 1.6)
- Waste Sample Collection Location (Release 1.6)

Monitoring Well

Air Quality Monitoring Station

- Groundwater Quality Monitoring Station (Release 1.6)
- Surface Water Quality Monitoring Station (Release 1.6)
- Landfill Gas Monitoring Probe
- Magnetometer Detection Location

Entity Class 3: Hazardous Materiels and Hazardous Waste Management

- Contained Hazardous Materiel Storage Area (Release 1.6)
- Contained Hazardous Waste Storage Area (Release 1.6)
- Contained Hazardous Materiel Storage Building (Release 1.6)
- Contained Hazardous Waste Storage Building (Release 1.6)
- Contained Hazardous Materiel Storage Room (Release 1.6)
- Contained Hazardous Waste Storage Room (Release 1.6)
- Contained Hazardous Materiel Storage Vault (Release 1.6)
- Contained Hazardous Waste Storage Vault (Release 1.6)

- Contained PCBs (Release 1.6)

Entity Class 5: Solid Waste Management

- Solid Waste Composting Facility
- Landfill Cell
- Solid Waste Compactor
- Landfill Leachate and Gas Collection Piping
- Landfill Gas Collection Well
- Landfill Gas Transport Compressor
- Landfill Gas Treatment Plant
- Solid Waste Incinerator
- Landfill Gas Flare Station
- Landfill Leachate Collection Sump
- Landfill Leachate Transport Pump
- Solid Waste Landfill
- Landfill Runoff Drain
- Landfill Leachate Treatment Plant
- Solid Waste Materiel Recovery Collection Facility
- Landfill Runoff Retention Area
- Solid Waste Dump
- Solid Waste StockpileSolid Waste Transfer Station
- Landfill Leachate and Gas Transport Piping

Entity Class 6: Pollution Remediation

- Temporary Stockpile Area
- Excavation Area

Entity Class 7: Building Hazard Remediation

- Building with Environmental Hazards

Entity Class 8: Emergency Preparedness

- Emergency Eyewash
- Emergency Shower
- Potential Release Location
- Spill Containment Feature
- Spill Containment Tank
- Spill Response Feature
- Spill Response Staging Area

Entity Class 9: Munitions Remediation

- Biological Warfare Waste Polluted Area
- Chemical Warfare Waste Polluted Area
- Munitions Waste Disposal Area
- Ordnance and Explosive Waste Polluted Area

Entity Class 10: General

- Contamination Reduction Zone
- Decontamination Line
- Equipment Decontamination Pad
- Exclusion Zone
- Onsite Command Post
- Seasonal Restriction Area
- Site Information Center
- Staging Area
- Support Zone
- Washdown Water Tank

Entity Class 11: Air Pollution

- Chemical Waste Polluted Air Area
- Medical Waste Polluted Air Area
- Mixed Waste Polluted Air Area
- Petroleum Waste Polluted Air Area
- Radioactive Waste Polluted Air Area
- Air Pollution Isoline
- Air Pollution Plume
- Air Emission Source Point (Release 1.6)
- Air Pollution Source Area (Release 1.6)

Entity Class 12: Soil Pollution

- Chemical Waste Polluted Soil Area
- Medical Waste Polluted soil Area
- Mixed Waste Polluted Soil Area
- Petroleum Waste Polluted Soil Area
- Radioactive Waste Polluted Soil Area
- Soil Pollution Isoline
- Soil Pollution Plume

Entity Class 13: Groundwater Pollution

- Chemical Waste Polluted Groundwater Area
- Medical Waste Polluted Groundwater Area
- Mixed Waste Polluted Groundwater Area
- Petroleum Waste Polluted Groundwater Area
- Radioactive Waste Polluted Groundwater Area
- Groundwater Pollution Isoline
- Groundwater Pollution Plume

Entity Class 14: Surface Water Pollution

- Chemical Waste Polluted Surface Water Area
- Medical Waste Polluted Surface Water Area
- Mixed Waste Polluted Surface Water Area
- Petroleum Waste Polluted Surface Water Area

- Radioactive Waste Polluted Surface Water Area
- Surface Water Pollution Isoline
- Surface Water Pollution Plume

Entity Class 15: Sediment Pollution

- Chemical Waste Polluted Sediment Area
- Medical Waste Polluted Sediment Area
- Mixed Waste Polluted Sediment Area
- Petroleum Waste Polluted Sediment Area
- Radioactive Waste Polluted Sediment Area
- Sediment Pollution Isoline
- Sediment Pollution Plume

Entity Class 16: General Pollution

- Hazardous Waste Disposal Area
- Pollution Source Point
- Spill Release Area
- Spill Release Point
- Nonpoint Source Pollution Area
- Polluted Area of Concern

Entity Class 17: Regulated Tank Management (Release 1.6)

- Regulated Underground Storage Tank
- Regulated Aboveground Storage Tank

Table 5
Selected Environmental Hazards Entity Set "Nongraphic" Attribute Tables

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Entity Class 1: Site Management

- Environmental Hazards Site
- Environmental Hazards Site Alias Name (Release 1.6)
- Environmental Hazards Site Contamination Class (Release 1.6)
- Environmental Hazards Site Group (Release 1.6)
- Environmental Hazards Site Polluted Matrix (Release 1.6)
- Environmental Hazards Site Regulatory Authority (Release 1.6)
- Environmental Hazards Site Past Usage (Release 1.6)

Entity Class 2: Characterization

- Environmental Field Sample Collection Occurrence
- Laboratory Analysis Chemical Results of Environmental Field Sample
- Laboratory Analysis of Environmental Field Sample

Entity Class 6: Pollution Remediation

- Pollution Remediation Operable Unit Target Matrix and Contaminants (Release 1.6)
- Pollution Remediation Operable Unit

Entity Class 7: Building Environmental Hazard Remediation

- Asbestos Containing Materiels
- Lead Hazard
- Indoor Air Hazard

Entity Class 16: General Pollution

- Polluted Area of Concern Contaminants (Release 1.6)
- Polluted Area Investigative Zone (Release 1.6)

Entity Class 17: Regulated Tank

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Management (Release 1.6)

- Regulated Tank